

MICROWAVE AND RF HEATING

MIGHTY MICROWAVES

Microwaves can be used for creating fusion plasmas, heating them, and driving electrical currents in them. The capability for producing the high-power microwaves needed for these purposes was created through an intensive development program involving industry, university, and national laboratory researchers. As a result of this program, the United States leads the world in the production of continuous-wave gyrotrons and related equipment. Industry, defense, and scientific research have already benefited from this technology development, and the potential for additional applications is being explored.

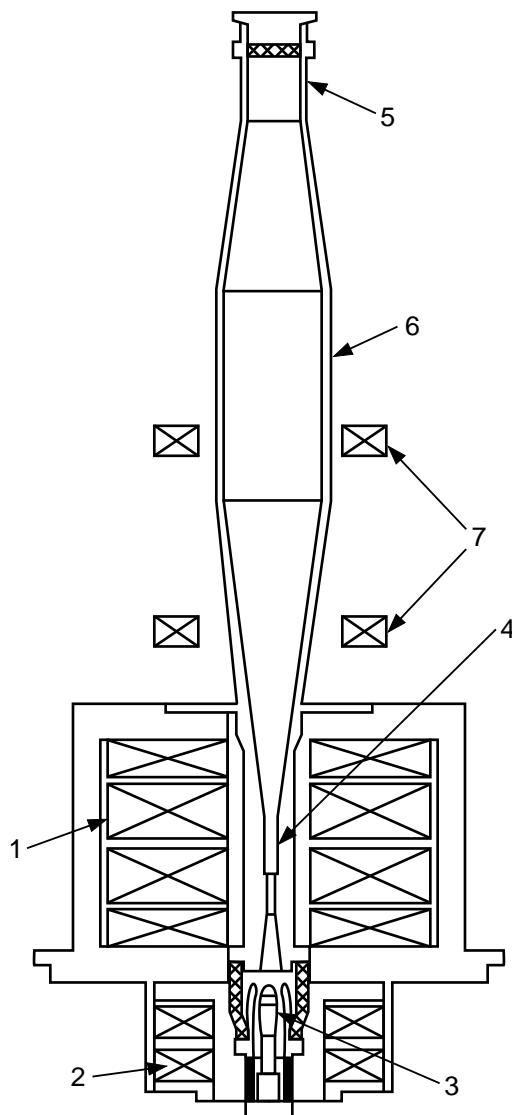
When electromagnetic fields interact with matter, energy is transferred from the fields to the molecular bonds of the matter, causing these bonds to “vibrate.” This vibrational energy is dissipated as heat.

Microwaves are a form of electromagnetic energy, with frequencies ranging from 300 MHz to 300 GHz. Depending on the frequency used, microwaves can be used to create a plasma, to heat the ions or electrons in the plasma, or to drive electrical currents in it.

One way to produce microwaves is with a device called a gyrotron, shown at right. Gyrotrons are particularly well suited for applications that involve high-frequency, millimeter-wavelength microwaves, such as radar, satellite links, and medical applications.

Gyrotrons were first developed in the former Soviet Union in the 1960s. As their usefulness for fusion research became apparent, the Department of Energy set up a program for the development of millimeter-wavelength power generators for use in plasma heating systems.

This program, over a number of years, combined basic gyrotron research at the Massachusetts Institute of Technology (MIT) and the Naval Research Laboratory; analytical and material development work by Lawrence Livermore National Laboratory, Oak Ridge



1. Main magnet coils
2. Gun magnet coil
3. Electron gun
4. Cavity
5. Output waveguide and window
6. Beam collector area
7. Collector magnet coils

